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DRAWINGS ATTACHED

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(54) ELECTRICAL COMPONENTS APPLIED TO VITREOUS BODIES

(71) We, THE TRIPLEX SAFETY GLASS COMPANY LIMITED, a British Company, of 1 Albemarle Street, London, W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electrical components applied to vitreous bodies. In particular the invention is concerned with non-transparent electrically-conductive bands applied to transparent vitreous bodies, the bodies being of glass or other transparent glass-like materials.

From one aspect the invention consists in a method of applying non-transparent electrical conductors to the surface of an electrically non-conductive transparent vitreous body so as to enable the body to be heated by the passage of electricity through the conductors, comprising the steps of applying a plurality of bands of metal-bearing substance to the surface of the body, the substance either bearing metal particles or comprising a chemical which yields metal particles when fired, and heating the body to fire the bands so that the metal particles cohere to form conductive bands which adhere to the body, overlaying each of the metallic bands with a layer of particles of a vitreous material and heating the body to fire the layer so that the particles of vitreous material cohere to form a continuous electrically non-conductive layer which covers and protects the metallic band, the layer which overlies each band extending only over that band and the adjacent part of the body on each side of the band so that there is a space between each layer and the next adjacent layer or layers.

From another aspect the invention consists in an electrically non-conductive transparent vitreous body with a plurality of electrically conductive, non-transparent bands applied to the surface thereof, made by the method outlined in the last preceding paragraph.

From yet another aspect the invention consists in an electrically non-conductive transparent vitreous body with a plurality of metallic, electrically conductive, non-transparent bands applied to the surface thereof and a layer of electrically non-conductive vitreous material covering each band, characterised in that the layer which covers each band extends only over that band and the adjacent part of the body on each side of the band so that there is a space between each layer and the next adjacent layer or layers.

The invention has been developed in connection with the formation of electrical heating resistances on toughened glass for use as windows for vehicles and is particularly, but not exclusively, applicable to such windows.

The metal particles are preferably mixed with a liquid or paste-like carrier and in which the band is caused or allowed to set before the firing process.

The preferred metal is silver, but any other suitable metal or metallic alloy may be used; for example other suitable metals are gold, platinum and palladium.

The metal-bearing substance may comprise a material in which the metal forms part of a chemical compound. For example the substance may comprise an organic silver compound which yields metallic silver when it is fired. Alternatively the metal-bearing substance may comprise metal particles which become sintered together when fired. Such particles are preferably in the form of flakes. The metal particles may be mixed with a liquid or paste-like carrier, a typical carrier being an essential oil, i.e. a readily volatile oil such as may be extracted from the flowers, leaves and roots of many plants. Silver flakes in such media are currently on the market and are sometimes referred to as "inks". Alternatively the metallic particles may be in a carrier,

[*Price 5s. 0d. (25p)*]

such as a synthetic resinous material which is thermoplastic and which can be applied when hot and in a liquid or paste-like state and which sets when it cools shortly after being applied. In a typical arrangement the flakes are of such a size that they pass through a 300 mesh screen, that is a screen with 300 holes per linear inch. The metallic flakes and the carrier with which they are mixed may be applied in any suitable manner, a particularly suitable method being a silk-screen printing process.

It is to be understood that the term silk-screen printing process is intended to cover any printing process involving the use of a partially imperforate and partially perforate screen, whether or not the screen is made of silk.

The vitreous particles of the non-conductive layer may also be mixed with a liquid or paste-like carrier before being applied to the metallic band and adjacent parts of the body. Here again the carrier is preferably such that it sets or can be caused to set after application and before firing. Essential oils or thermoplastic synthetic resinous materials are again suitable carriers. The particular vitreous material preferably comprises glass frit, the glass preferably being selected so that it can be softened to cohere at a temperature below that at which the vitreous body becomes soft; the glass also preferably being such that the co-efficient of thermal expansion is substantially equal to that of the transparent vitreous body.

The particles of vitreous material in their carrier may be applied by any suitable method, a preferred method again being a silk-screen printing process.

Although the layers of vitreous material are arranged to overlie the metallic bands and the adjacent parts of the body, at least one part of the band or of one of the bands is preferably left uncovered so that an electrical connection can readily be soldered or otherwise connected to it.

The metallic bands may be fired before the layers of vitreous particles are applied to them, so that a second firing is necessary for the vitreous layers. In a preferred method, however, the metallic bands and the layers of vitreous particles are fired in a single firing process.

Where the base comprises a sheet of toughened glass the firing of the covering layers, and preferably the firing of the bands, may conveniently be arranged to occur when the sheet of glass is heated for toughening. In this way no heat treatment of the glass is necessary additional to that normally used in toughening glass. Similarly the firing process or (where two firing processes are involved) one or both of the firing processes may be carried out simultaneously with the heating of a glass sheet preparatory to a bending process. It is found that if metallic bands are applied to a surface of a transparent vitreous sheet which is later bent to a concave shape no difficulties normally arise. If, however, they are applied to a surface which is later bent to a convex shape it is normally necessary to provide thicker bands than would otherwise be the case in order to ensure that the bands remain continuous after bending.

The invention will now be more particularly described with reference to the accompanying drawings, in which:—

Figure 1 represents a vehicle window to which heating bands have been applied;

Figure 2 is similar to Figure 1, but shows an alternative arrangement of heating bands;

Figure 3 is a section to an enlarged scale along the line 3—3 of Figure 1; and

Figure 4 represents another shape of vehicle window to which yet another arrangement of heating bands has been applied.

In making the vehicle window shown in Figures 1 and 3 a sheet of glass 10 is cut to shape and finished in the usual way, and a plurality of metal bands 11 (see Figure 3) are formed on it. The bands 11 are formed by applying a silver-bearing substance to the glass sheet 10 by a silk-screen printing process. The silver-bearing substance may comprise silver flakes mixed with a paste-like carrier comprising a thermoplastic resin, the flakes being of a size such that they can pass through a 300 mesh screen. Such a substance is applied while hot, and sets as it cools. A typical substance of this kind is marketed by the Hanovia Division of Englehard Industries Limited under the description "Hanovia Thermoplastic Silver Paste No. 8095/HC". Alternatively the silver-bearing substance may comprise a material in which the silver forms part of an organic compound, the material yielding metallic silver on firing. A typical substance of this kind is marketed by Englehard Industries Limited under the reference "8258".

After the silver-bearing substance has set or been caused to set a layer of vitreous material is applied to each of the bands 11, and the adjacent parts of the glass sheet 10. The layer is formed by applying glass frit in a liquid or paste-like carrier by means of a silk-screen printing process. The glass frit is such that it can be softened to cohere at a temperature below that at which the glass sheet 10 becomes soft, and is such that its co-efficient of thermal expansion is substantially equal to that of the glass sheet. The carrier may be of any of the kinds described above. Suitable glass frits mixed with carriers are those marketed by C. E. Ramsden & Company Limited under the

following descriptions:—"Cold Glass Frit No. RE. 1137/M202/45/HC", "Thermoplastic Glass Frit No. E4545/HC", and "Clear Flux E 4488/202".

After the layer incorporating the glass frit has set or been caused to set the whole assembly is fired in an oven with the result that the silver coheres to form continuous metallic bands 11 and the frit coheres to form a protective layer 12 for the bands. The firing may conveniently form part of a toughening process for the glass sheet 10.

In the arrangement shown in Figure 1, which is intended for use as the rear window of a motor vehicle, there are a plurality of composite strips 13, each comprising a band of silver overlaid with a protective layer of vitreous material, the strips 13 being mutually parallel and extending between a pair of common feed conductors 14 which are similar to the strips 13 but are wider than the strips 13. In a typical arrangement the silver bands of the strips 13 are between 0.0003 inches and 0.0005 inches thick and are 0.015 inches wide. The gap between adjacent strips 13 is between 1.0 inches and 1.25 inches. Using a 12 volt d.c. supply, as is normal in motor vehicles, a heat dissipation of about 35 watts per square foot can be obtained. This normally causes quite rapid demisting, the window being completely clear in between 3 and 5 minutes in a temperate climate. The silver bands of the feed conductors 14 are about 0.19 inches wide and therefore dissipate a negligible amount of heat. To reduce this heat dissipation still further solder-coated copper tape may be soldered along the length of the metal bands. Typical tape is 0.002 inches thick and 0.125 inches wide. When a copper tape is used the tape is not covered with a layer of vitreous material.

The ends of the feed conductors 14 may be left without a vitreous cover, and leads 15 in the form of metal tapes or wires can be soldered to them. Alternatively, if copper tapes are soldered to the feed conductors 14 extensions of these tapes may constitute the leads 15.

The arrangement shown in Figure 2 is generally similar to that shown in Figure 1, but here the transverse strips 13 are replaced by upright strips 16. The strips 16 extend between feed conductors 17 which are so arranged, as illustrated, that there are several sets of strips extending in electrical parallel between common feed conductors, the sets being in electrical series with each other. The end feed conductors have leads 18 similar to the leads 15.

The windows shown in Figures 1 and 2 may be mounted in the usual manner in rubber or similar glazing strips, the feed conductors 14 and 17 being concealed by the glazing strips.

In the arrangement shown in Figure 4 there is a glass sheet 19 to which a plurality of strips, generally similar to the strips 13 and 16, have been applied. The strips are arranged in a pattern such that in a central part of the sheet of glass 19 there is a plurality of parallel, horizontal, strips 20 spaced uniformly apart, and on each side is an end part having a common conductive panel 21 at the lower, outer edge, connected by radiating strips 22 to the adjacent ends of the horizontal strips 20 on the central part. The radiating strips 22 are tapered to become narrower as they extend further from the common panel 21, and the lower horizontal strips 20 are wider than the upper ones, the arrangement being such that over any area including a few short lengths of adjacent strips the dissipation of heat is substantially uniform.

WHAT WE CLAIM IS:—

1. A method of applying non-transparent electrical conductors to the surface of an electrically non-conductive transparent vitreous body so as to enable the body to be heated by the passage of electricity through the conductors, comprising the steps of applying a plurality of bands of metal-bearing substance to the surface of the body, the substance either bearing metal particles or comprising a chemical which yields metal particles when fired, and heating the body to fire the bands so that the metal particles cohere to form conductive bands which adhere to the body, overlaying each of the metallic bands with a layer of particles of a vitreous material and heating the body to fire the layer so that the particles of vitreous material cohere to form a continuous electrically non-conductive layer which covers and protects the metallic band, the layer which overlies each band extending only over that band and the adjacent part of the body on each side of the band so that there is a space between each layer and the next adjacent layer or layers.

2. A method according to Claim 1 in which the metallic bands and the vitreous layers are fired in a single firing process.

3. A method according to either of Claims 1 and 2 in which the metal-bearing substance is applied to the vitreous body by a silk-screening process.

4. A method according to any of the preceding claims in which the vitreous particles are mixed with a liquid or paste-like carrier before being applied to the metallic bands and adjacent parts of the body.

5. A method according to Claim 4 in which the vitreous particles and their carrier are applied by a silk-screening process.

6. An electrically non-conductive transparent vitreous body with a plurality of metallic, electrically conductive, non-trans-

parent bands applied to the surface thereof, made by the method claimed in any one of Claims 1 to 5.

7. An electrically non-conductive transparent vitreous body with a plurality of metallic, electrically conductive, non-transparent bands applied to the surface thereof and a layer of electrically non-conductive vitreous material covering each band, characterised in that the layer which covers each band extends only over that band and the adjacent part of the body on each side of the band so that there is a space between each layer and the next adjacent layer or layers.

8. An electrically non-conductive transparent vitreous body according to Claim 7 and substantially as hereinbefore described with reference to and as shown in any of the accompanying drawings.

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1202522 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG.1.

FIG.2.

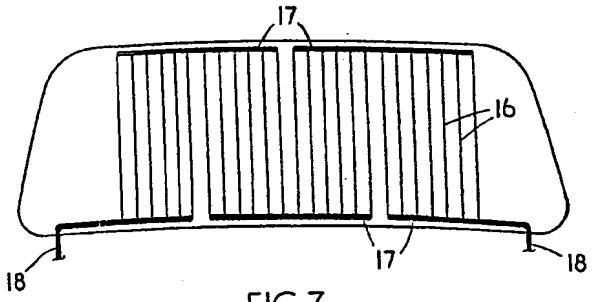

FIG.3.

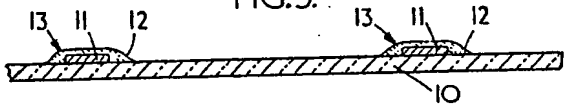

FIG.4.